

TWO DIMENSIONAL ARRAYS OF PLATINUM NANOCRYSTALS FABRICATED BY ELECTRON BEAM LITHOGRAPHY

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INTRODUCTION

The ability to tune size, shape and morphology of nanoparticles is of great significance because these properties provide subtle control of the chemical and physical characteristics of the building material. Platinum nanoparticles have been extensively studied for their unique catalytic properties (1). The performance of platinum nanoparticles in catalytic processes is highly dependent on the exposed facets. Furthermore, faceted platinum nanoparticles have been shown to exhibit higher catalytic activity compared to spherical particles (2). Thus, the ability to create nanoparticle of a uniform size, shape and orientation, as well as possibility to control the nanoparticle distribution in space, is important for both model catalyst studies and improvement of real systems. To meet these requirements, electron beam lithography (EBL) has been used to fabricate the model catalyst systems (3, 4).

RESULTS

Our research focuses on molecular level study of oxygen reduction reaction (ORR), place-exchange oxidation and absorption behavior of oxyspecies on nanofacets. Investigation of interaction between model catalyst and oxyspecies, i.e., initial absorption and subsequent activation of molecular oxygen in the gas phase and in electrolyte, is directed towards understanding electrocatalysis of fuel cell cathodes.

We have implemented EBL to fabricate two dimensional arrays of Pt nanoparticles supported on a glassy carbon substrate. We have grown Pt nanoparticles of controlled size in range between 50 to 100 nm, and well defined periodicity. Characterization of this system has been performed by atomic force microscopy (AFM), scanning tunneling microscopy (STM) and scanning electron microscopy (SEM). Selection of the glassy carbon as support surfaces is step towards more “realistic”

nanocatalyst system. Because of the high activity of platinum nanoparticles, reactions other than ORR may occur, such as oxidation of organic materials, including carbon catalyst support. In this way we have possibility to monitor structural and chemical evolution and transitions that occur on a nanofaceted surface in the environment that closer resembles real system. Fabrication method we used is not material dependent; therefore, a variety of metals can be coupled with a range of support materials. Furthermore, understanding of shape control of platinum nanoparticles can also lead to strategies for the shape control of other transition metal nanocrystals, including multicomponent systems.

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